EFFECT OF VISCERAL AND TOTAL BODY FAT REDUCTION IN OBESE FEMALES WITH STRESS URINARY INCONTINENCE

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Abstract

Background and Purpose: This research intended to investigate the effect of visceral fat as well as total body fat reduction on stress urinary incontinence (SUI) in obese females.

Subjects and Methods: 60 obese women with SUI took part in this research. They were between 35 and 50 years old also their body mass index (BMI) was >29.9 kg/m^2. They were put into three equal-sized groups at random. Control group received pelvic floor muscles (PFM) exercise three session/week for 12 weeks; diet group received PFM exercise and low caloric diet (800-1200) calories/day; and ultrasound cavitation (UC) group received PFM exercise and UC two session/week for 12 weeks. Body mass index (BMI) as well as waist circumference (WC) were measured; visceral fat (VF) and total body fat (TBF) were measured using body composition analyzer; PFM strength was measured using EMG biofeedback device and urinary functions were evaluated using international consultation on incontinence questionnaire (ICIQ).

Results: Both diet and UC groups revealed a substantial decline (p=0.001) in BMI, WC, TBF, VF, and ICIQ score and a substantial improvement (p=0.001) in PFM strength after treatment. Contrasted to the control group, both diet as well as UC groups revealed a substantial improvement (p=0.001) in the mean difference of BMI, WC, TBF, VF, ICIQ score, and PFM strength. Compared to the UC group, the diet group revealed a substantial improvement (p= 0.001) in the mean difference of BMI, TBF, and VF and non-significant difference (p>0.05) in WC, ICIQ score and PFM strength.

Conclusions: The UC has a similar effect to low-calorie diet in improving SUI symptoms and PFM strength in obese women. So, both methods could be used alternatively in the treatment protocol of SUI in obese women.

Keywords: Stress urinary incontinence. Diet. Ultrasound cavitation. Visceral fat. Total body fat. Pelvic floor muscle strength

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Introduction

Stress urinary incontinence (SUI) is defined as the leaking of urine involuntary on effort, coughing or sneezing occurring when intrabdominal pressure exceeds the urethral closure pressure [1]. It is the most common type of urinary incontinence, which occurs in mixed or pure form in 80% of incontinent women [2]. The prevalence of SUI is 4-35% in middle aged patients [3].

SUI has a negative effect on women's quality of life [4,5]. Patients' social, psychological [6], familial, occupational, physical, and sexual aspects might be negatively impacted [7]. Various studies demonstrated a high prevalence of concomitant psychiatric problems in women with urine incontinence, including depression [8].

A higher trunk fat percentage and BMI are strongly associated to urinary incontinence in women that is more severe and more common [1]. Multiple epidemiological studies noted that obesity is a significant risk factor for developing urine incontinence [9]. Each 5-unit increase in BMI is linked to a 60% increase in risk of incontinence because BMI raises the pressure of intra-abdominal compressing pelvic floor muscles contributing to SUI [10]. There were highly significant trends toward an increasing risk of incontinence with increasing abdominal adiposity and waist circumference; urinary incontinence was independently related with every 10 centimeters of increase in waist circumference [11].

Diet restriction programs alone or combined with exercise showed evidence that weight loss interventions have the potentials to improve urinary incontinence in overweight women [12]. Ultrasound cavitation (UC) is a non-invasive technological method for mobilizing localized fat stores that is both safe and effective. When compared to conventional liposuction methods, this one is safer and less invasive. Ultrasonic lipolysis waves remove excess fat from the body without harming the skin [13].

To authors' knowledge, no studies investigated the effect of reducing visceral fat (VF) and total body fat (TBF) using diet regime compared with UC on SUI symptoms and PFM strength in obese females. As a result, the purpose of this research was to examine at the impact of diet regime compared with UC on anthropometric measurement, TBF, VF, urinary functions, PFM strength in obese women with SUI. This study hypothesized that it would be no difference in the outcomes between diet regime and UC.

Subjects and Methods

Design

The study is a retrospective, randomized, controlled trial. From April 2021 until June 2023, it was carried out. Each participant in this study signed an informed consent form after receiving an explanation of the study's protocol.

Participants

A gynaecologist recruited a sample of 60 obese women with SUI grade≥ 1. They were selected from Obstetric and Gynecological Department. Their age ranged from 35 to 50 years, BMI exceeded 29.9 kg/m^2, and their WHR was more than 0.85 cm. Exclusion criteria included fecal incontinence, urge incontinence, overflow incontinence, functional incontinence, prolapse, diabetes, asthma, cardiovascular and renal diseases, gynecological surgeries or taking medication for SUI or hormonal replacement therapy.

Randomization

An independent person used a sealed envelope system to put sixty patients into three groups of equal size; Whether the ladies were assigned to the diet group, the UC group, or the control group was detailed in the letter that was enclosed in the envelope. The patients were blinded about which group they were be allocated. Control, diet, and UC groups received supervised PFM exercises three session/week for 12 weeks. In addition, diet group received low caloric diet (800-1200) calories/day, as well as UC group received UC two sessions/week for 12.

Interventions

1. **Pelvic floor muscles exercises**

All woman in the control, diet, and UC groups performed PFM exercises. The physical therapist externally observed PFM while the woman in the lithotomy position and described to her how to feel her PFM when she stopped mid-stream urine. The therapist gently palpated the PFM to verify that the patient was able to identify the correct muscle and contract it. Then, each woman performed quick flick exercise in which she contracted PFM as fast as she could for ten times then relaxed. In slow contraction exercise, she contracted her PFM as hard as she could for 10 times, hold for 10 seconds, and relaxed. Then, she practiced sustain contraction exercises in which she contracted her PFM halfway, hold for 60 seconds, and repeated for 5 times. Repetitions increased to reach 100 contractions/day in the first month, 200 in the second month, and 300 in the third month. She performed supervised PFM exercise program

three sessions/week and twice per day as home program for 12 weeks [14].

2. **Low caloric diet**

All woman in the diet group received low caloric diet (800-1200) calories/day [15]. Diet regime included 50 to 55% of carbohydrates, 10 to 15 % of protein, and less than 28% of fat. Saturated fats were less than 8% [16]. It also contained fruits, (2.5-3) liter water/day, and unsaturated fatty acid (healthy fat) like nuts olive oil or sesame seeds. Total calories were gradually decreased; women received 1200 calories in the first month, 1000 calories in the second month, and 800 calories in the third month. Each woman selected her foods according to a food list given to her. Each schedule had breakfast, dinner, lunch, and two snacks between meals. Each week, she was allowed to change the types of food to avoid boarding; however, she did not change the amount of food.

3. **Ultrasound cavitation (UC)**

All woman in UC group received UC sessions using the UC device (AU-62, China). It has the following characteristics: it emits low-frequency pulsed ultrasound; its weight is 18 k; its power is 500 W, and its voltage is 110-120 V, 50-60 HZ. Undergoing continuous emission at 40 KHz, 3-6 W/cm2, with a 10cm2 active surface, they acquired UC on the abdomen region. Treatment was applied 30 minutes, twice/week with three days apart for 12 weeks [17].

Outcome measures

1. **Anthropometric measurement**

A blinded examiner to the group assignment measured weight and height for each woman to calculate BMI. Also, Before and after therapy, she had all of the ladies have their waist circumference measured at the midpoint between both the bottom of their last palpable rib as well as the top of their iliac crest [18].

2. **Assessment of Visceral fat and total body fat**

Body composition analyzer was a valid, reliable, and more acceptable method for measuring body fat composition containing VF and TBF [19]. It was a bioelectrical impedance analysis unit (BODECODER) having the following features: Machine display: 5 inches color LCD touch screen; Capacity: 150 kg; Weight range: 1-150 kg; Height range 100-220 cm; Frequency: 50KHz; Current: 0.5mA and Measuring time: <10s. VF and TBF were measured for all women before and after the treatment.

3. **Assessment of pelvic floor muscle strength**

EMG biofeedback device (NeuroTrac simplex model, England) was used to measure the PFM strength. It was a valid and reliable method for assessing PFM strength. It measured muscle activity from 2mv up to 2000 mv; work/rest periods were 2 to 99 seconds; number of trials was 1 to 99; the power needed was 9v. Each woman assumed crock lying position while inserting single vaginal probe in the vagina using KY gel and placing the surface electrode (reference electrode) on hip or forearm. Each woman relaxed as much as she could when hearing single beep sound and the display was showing the arrow down. Then, she contracted as fast as she could when hearing double beep sound and the display was showing the arrow up. She performed 5 trails contractions for 5 seconds and 5 trails relaxations for 3 seconds; the device provided the mean result of PFM activity in mv [20].

4. **Assessment of urinary functions**

International consultation on incontinence questionnaire (ICIQ)-short form was used to evaluate urinary functions for each woman in all groups. It provided information about frequency of UI, leaking amount, overall impact of UI, as well as self-diagnostic item. Scores on the questionnaire varied from 0 to 21 according to Klovning et al. [21]. Validity, reliability, and responsiveness of this questionnaire were established. Each woman was instructed carefully about questionnaire and given a full time to fulfil it before and after the treatment course [22].

Statistical analysis

The data was analysed using the SPSS for Windows (version 20) statistical software package for social sciences. The Kolmogorov-Smirnov test was performed to examine the normality of the data distribution. Therefore, one way analysis of variance (ANOVA) was used to compare normally distributed variables across the three groups, and the Least Significant Difference (LSD) test was applied if statistical significance was found. Kruskal-Wallis test was used to compare variables across the three groups, with the Mann Whitney test being used to determine statistical significance if necessary. Comparison within the same group was carried out using Wilcoxon Sign Ranks test. Assuming a P value of less than 0.05 indicated statistical significance.

Results

(Tables 1-3) The control group revealed no substantial difference in the BMI (p=0.349), WC (p= 0.471), TBF (p=0.925), as well as VF (p=0.488). Nevertheless, it showed a statistically substantial decline (p=0.001) in ICIQ score as well as a statistically substantial improvement (p= 0.001) in the PFM strength after treatment. Diet participants manifested a statistically substantial decline (p=0.001) in BMI, WC, TBF, VF, and ICIQ score and a statistically substantial improvement (p=0.001) in the PFM strength after treatment. Also, the UC group revealed a statistically substantial decline in the BMI (p= 0.001), WC (p=0.001), TBF (p=0.004), VF (p=0.001), and ICIQ score (p=0.001) as well as a statistically substantial improvement (p= 0.001) in the PFM strength after treatment.

The diet group and the UC group both increased significantly as contrasted to the control group (p=0.001) in the mean difference of BMI, WC, TBF, VF, ICIQ score, as well as PFM strength. Contrasted to the UC group, the diet group revealed a statistically substantial improvement (p= 0.001) in the mean difference of BMI, TBF, and VF and non- substantial difference in WC (p=0.237), ICIQ score (p=0.114), and PFM strength (p=0.862).

Discussion

Obesity has a great influence on SUI in women; the spread of pelvic floor defect increases with the severity of obesity [23]. Obesity appears to give a two-fold and four-fold increased hazard of anal and urinary incontinence, it is significantly combined with severe troubles that have bad effects on general health and interfere with daily level activities [24]. So, research intended to examine the impact of UC compared with diet regime on anthropometric measurements, TBF, VF, urinary function, and PFM strength in obese women.

In this study BMI, WC, TBF, VF, ICIQ score, and PFM strength showed a substantial improve in the diet group as well as UC group. However, the diet group showed more improvement in the BMI, TBF, and VF than UC group.

The findings of this study consistent with preceding studies; evidenced that low-calorie diet for three months resulted in a reduction of BMI as well as urinary incontinence frequency among obese women [25,26]. Additionally, compared to women using metformin, those who made changes to their way of life had much lower rates of stress and urge incontinence [27].

Moreover, a weight reduction program including diet and exercises for six months showed significant reductions in BMI and WC, which were associated with a significant reduction in nocturia, and urinary leakage due to a decrease in abdominal and vesical pressures [9,28-30]. Also, it showed a significant improvement in episodes of urinary incontinence, pelvic floor distress

Table 1: Baseline characteristics of all variables in the control, diet, and UC groups.

Variables	Control group (n= 20)	Diet group (n= 20)	UC group (n= 20)	p-value
Age	38.95 ± 4.10	39.90 ± 3.70	41.15 ± 4.02	0.217 NS##
Weight	94.42 ± 10.79	103.42 ± 23.63	95.70 ± 21.36	0.292 NS##
Height	161.82 ± 5.56	160.60 ± 5.85	159.18 ± 5.91	0.355 NS##
Body mass index (BMI)	35.92 ± 3.68	40.08 ± 9.76	37.75 ± 7.31	0.747 NS#
Waist circumference (WC)	110.80 ± 6.52	118.72 ± 15.13	115.20 ± 8.94	0.085 NS#
Total body fat (TBF)	44.992 ± 3.960	47.620 ± 4.136	46.535 ± 3.837	0.158 NS#
Visceral fat (VF)	10.815 ± 3.132	14.385 ± 7.207	12.70 ± 5.820	0.369 NS#
ICIQ score	15.50 ± 2.50	16.55 ± 2.61	15.20 ± 2.93	0.254 NS#
PFM strength	13.42 ± 7.96	10.82 ± 6.12	12.44 ± 8.77	0.850 NS#

Data are expressed as mean ± SD; # = Kruskal Wallis ANOVA test; ## = One way ANOVA test; NS: non-significant; ICIQ: International Consultation on Incontinence Questionnaire; PFM: pelvic floor muscle

Table 2: Comparison of mean differences among the control, diet, and UC groups.

Variables	Control group (n= 20)	Diet group (n= 20)	UC group (n= 20)	Overall p value	P value		
					Control vs Diet	Control vs UC	Diet vs UC
Body mass index (BMI)	-0.24 ± 1.72	5.39 ± 2.57	2.13 ± 1.66	0.001*#	0.001*	0.001*	0.001*
Waist circumference (WC)	0.30 ± 2.18	16.54 ± 7.62	13.70 ± 5.97	0.001*#	0.001*	0.001*	0.237NS
Total body fat (TBF)	-0.298±2.247	4.465 ±2.946	1.365 ± 1.730	0.001*#	0.001*	0.007*	0.001*
Visceral fat (VF)	0.080 ±0.449	2.665 ±1.397	1.590 ± 1.606	0.001*#	0.001*	0.001*	0.001*
ICIQ score	5.50 ± 2.98	11.00 ± 3.08	9.85 ± 3.20	0.001*#	0.001*	0.001*	0.114 NS
PFM strength	4.35 ± 1.40	18.28 ± 8.45	22.56 ± 12.82	0.001*#	0.001*	0.001*	0.862 NS

Data are expressed as mean ± SD; #= Kruskal Wallis ANOVA test; NS: non-significant; *=significant; ICIQ: International Consultation on Incontinence Questionnaire; PFM: pelvic floor muscle.

inventory, and incidence of drops of urine leakage [31].

Another study conducted for 1-year reported that loss of 5%-10% of body weight reduced risk for SUI by 33% in diabetic women [32]. In addition, a supervised intensive lifestyle changes for 18 months significantly induced improvements health-related quality of life among overweight as well as obese women having UI [33].

The results of a meta-analysis of six trial utilized diet restriction programs alone or combined with exercise demonstrated that conservative weight loss methods involving no surgical procedures reduced urine incontinence among overweight women [12]. Also, another systematic review reported that behavioral weight loss interventions including diet modification, exercise programs, medications, as well as /or counseling induced moderate enhancements in stress in addition to the overall UI among overweight as well as obese women [34]. Ketogenic diets have been shown to lower weight, BMI, VF, as well as body fat percentage among postmenopausal obese women experiencing mild to moderate SUI, according to a recent study [35].

The results disagreed with Auwad et al. who reported that PFM strength did not show a significant improvement after weight loss program in women with urinary incontinence. The lack of randomized controlled design, loss of blinding procedures, and use of multiple observers for measuring PFM strength may explain the non-significant improvement in PFM strength in the reported study [36].

Regarding to the results of UC, the results agreed with prior research; the findings indicated that adding UC to diet intervention was effective for abdominal contouring and reduction of abdominal fat thickness as it improved WC and suprailiac skinfold than the diet-only group [37]. Also, application of 10-week UC showed a significant decrease in WC and abdominal fat thickness assessed via ultrasonography in patients with abdominal obesity [38]. The decreased WC and SUI symptoms, and improved PFM strength may be attributed to decreased VF, which produced pressures on the PFM. The induced improvement of VF could be explained via the UC effect on Fat; UC produces bubbles in the fat tissue, which expand and immediately compress, the pressures causes the temperature to rise, then the bubbles pop [39]. The fat cell is damaged by the implosion; triglycerides are transformed to di glycerides, distributed in the interstitial fluid between the cells, removed by means of the lymphatic system, and subsequently delivered to the liver via the bloodstream. Subsequently, the lipase enzyme converts fatty acids into glycerol as well as free fatty acids. Glycerol is phosphorylated then carried into the bloodstream [40]. The 3-free fatty acids are delivered to the liver via being attached to albumin molecules. Metabolites derived from dietary fat undergo the same liver processing as dietary fat itself; The kidneys are responsible for excreting excess fat [41].

Limitations

A number of limitations exist, despite the fact that the current study does show objective data showing statistically substantial differences. The main one is that there isn't much time to study. So, study is required to find out how diet and US cavitation affect VF, TBF, urinary symptoms, bladder severity symptoms, as well as quality of life over the long term. More research is needed to find the best and most useful parameters of US cavitation. More research is needed to compare various types of diets as well as other forms of UC in obese women with SUI.

Conclusions

The study demonstrated total body fat loss (via low-calorie diet) or local (abdominal/visceral) fat loss (via ultrasound cavitation) are effective in improving TBF, VF, WHR, BMI, WC, ICIQ-SF, and PFM strength in obese women with SUI, but no significant difference between diet and UC regarding ICIQ-SF and SPFM.

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Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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Ethical approval:

The protocol of the study was approved by the Ethical Committee of the Faculty of Physical Therapy at Cairo University (P.T.REC/012/002815). The study was registered in clinical trials.gov protocol Registration (NCT05944484).

Consent

The procedures of this study were explained to all participants, who signed consent form before the beginning of the study

References

Ruffolo, A. F., Braga, A., Torella, M., Frigerio, M., Cimmino, C., De Rosa, A., ... & Serati, M. (2022). Vaginal laser therapy for female stress urinary incontinence: New solutions for a well-known issue—A concise review. Medicina, 58(4), 512

Shi, H., Zhao, L., Cui, L., Wang, Z., Wang, D., Liu, P., ... & Liu, W. (2022). A critical overview of systematic reviews and meta-analyses of acupuncture for female stress urinary incontinence. Pain Research and Management, 2022.

Haylen, B.T. (2010). An International Urogynecological Association (IUGA)/ International Continence Society (ICS) joint report on the terminology for female pelvic floor dysfunction. Neurourol. Urodyn. 29, 4.

Chen, J., Peng, L., Xiang, L., Li, B., Shen, H., & Luo, D. (2022). Association between body mass index, trunk and total body fat percentage with urinary incontinence in adult US population. International Urogynecology Journal, 1-8.

Horng, S. S., Huang, N., Wu, S. I., Fang, Y. T., Chou, Y. J., & Chou, P. (2013). The epidemiology of urinary incontinence and it's influence on quality of life in Taiwanese middle-aged women. Neurourology and urodynamics, 32(4), 371-376.

Huang, W., Li, X., Wang, Y., Yan, X., & Wu, S. (2017). Electroacupuncture for women with stress urinary incontinence: protocol for a systematic review and meta-analysis. Medicine, 96(49). Article ID e9110, 2017.

Mallah, F., Montazeri, A., Ghanbari, Z., Tavoli, A., Haghollahi, F., & Aziminekoo, E. (2014). Effect of Urinary Incontinence on Quality of Life among Iranian Women. Journal of family & reproductive health, 8(1), 13–19.

Debus, G., & Kästner, R. (2015). Psychosomatic Aspects of Urinary Incontinence in Women. Geburtshilfe und Frauenheilkunde, 75(2), 165–169.

Subak, L. L., Richter, H. E., & Hunskaar, S. (2009). Obesity and urinary incontinence: epidemiology and clinical research update. The Journal of urology, 182(6 Suppl), S2–S7.

Swenson, C. W., Kolenic, G. E., Trowbridge, E. R., Berger, M. B., Lewicky-Gaupp, C., Margulies, R. U., Morgan, D. M., Fenner, D. E., & DeLancey, J. O. (2017). Obesity and stress urinary incontinence in women: compromised continence mechanism or excess bladder pressure during cough?. International urogynecology journal, 28(9), 1377–1385.

Subak, L. L., Richter, H. E., & Hunskaar, S. (2009): Obesity and urinary incontinence: epidemiology and clinical research update. The Journal of urology, 182(6 Suppl), S2–S7

Vissers, D., Neels, H., Vermandel, A., De Wachter, S., Tjalma, W. A., Wyndaele, J. J., & Taeymans, J. (2014). The effect of non-surgical weight loss interventions on urinary incontinence in overweight women: a systematic review and meta-analysis. Obesity reviews: an official journal of the International Association for the Study of Obesity, 15(7), 610–617.

Assim, Yasmin & El-Aziz, Khadiga & Elrefaye, Ghada & Youssef, Ashraf. (2020). Effect of ultrasound cavitation versus radiofrequency on abdominal fat thickness in postnatal women. Eurasian Journal of Biosciences. 14. 3337-3347.

Frawley, H.; Haylen, B.; Abramov, Y.; Almeida, F.; Berghmans, B.;Borotolini, M.;, Dumoulin, C.; Gomes, M.; McClurg, D.; Meijink, J.;Shelly, E.; Trabuco, . And Walker, C. (2017): "International Urogynecological Association (IUGA) / International Continence Society (ICS) Joint Report on the Terminology for the Conservative and Non-pharamacological Management of Female Pelvic Floor Dysfunction",Int Urogynecol J, 28 (2): 191-213

Leeds,A.(2014): "Formula food-reducing diets:A new evidence-based addition to the weight management tool box".39(3): 238–246.

Adrienne- Youdi, and David –Geffen,D.(2019): "Carbohydrates, Proteins, and Fats".school of Medicine at UCLA.

Mohamed –Taher. ; Mahmoud- ELdesoky.; Enas- EL sayed.; Mohamed-Abutaleb.; Gihan –Samir. And Mohamed- Mousa. (2015):"Ultrasound cavitation versus cryolipolysis for non-invasive body contouring".

Geneva. (2008): "Waist Circumference and Waist-Hip Ratio Report of a WHO Expert Consultation".

Vasold, K. L., Parks, A. C., Phelan, D. M. L., Pontifex, M. B., & Pivarnik, J. M. (2019). Reliability and Validity of Commercially Available Low-Cost Bioelectrical Impedance Analysis. International journal of sport nutrition and exercise metabolism, 29(4), 406–410.

Brazález, B.;| Lacomba, M. AND Villa, P. (2017): "The evaluation of pelvic floor muscle strength in women with pelvic floor dysfunction", A reliability and correlation study.

Klovning A.; Avery, K.; Sandvik, H. and Hunskaar, S. (2009): "Comparison of two questionnaires for assessing the severity of urinary incontinence", The ICIQ-UI SF versus the incontinence severity index.

Abrams, P.; Jackson, S.; Donovan, J.; Brookes, S.; Eckford, S. and Swithinbank, L. (2007): "urinary incontinence in women: quality of life and help-seeking", 166(18)2000-2006.

Whitcomb, E. L., & Subak, L. L. (2011). Effect of weight loss on urinary incontinence in women. Open access journal of urology, 3, 123–132.

Ballard, A. C., & Richter, H. E. (2011). The Impact of Obesity and Weight Loss on Urinary and Bowel Incontinence Symptoms in Women. Menopausal medicine : for clinicians who provide care for women, 19(3), S1–S7.

Subak, L. L., Johnson, C., Whitcomb, E., Boban, D., Saxton, J., & Brown, J. S. (2002). Does weight loss improve incontinence in moderately obese women?. International urogynecology journal and pelvic floor dysfunction, 13(1), 40–43.

Subak, L. L., Whitcomb, E., Shen, H., Saxton, J., Vittinghoff, E., & Brown, J. S. (2005). Weight loss: a novel and effective treatment for urinary incontinence. The Journal of urology, 174(1),

Brown, J. S., Wing, R., Barrett-Connor, E., Nyberg, L. M., Kusek, J. W., Orchard, T. J., Ma, Y., Vittinghoff, E., Kanaya, A. M., & Diabetes Prevention Program Research Group (2006). Lifestyle intervention is associated with lower prevalence of urinary incontinence: the Diabetes Prevention Program. Diabetes care, 29(2), 385–390.

Auwad, W., Steggles, P., Bombieri, L., Waterfield, M., Wilkin, T., & Freeman, R. (2008). Moderate weight loss in obese women with urinary incontinence: a prospective longitudinal study. International urogynecology journal and pelvic floor dysfunction, 19(9), 1251–1259.

Wing, R. R., Creasman, J. M., West, D. S., Richter, H. E., Myers, D., Burgio, K. L., Franklin, F., Gorin, A. A., Vittinghoff, E., Macer, J., Kusek, J. W., Subak, L. L., & Program to Reduce Incontinence by Diet and Exercise (PRIDE) (2010 A). Improving urinary incontinence in overweight and obese women through modest weight loss. Obstetrics and gynecology, 116(2 Pt 1), 284–292.

Wing, R. R., West, D. S., Grady, D., Creasman, J. M., Richter, H. E., Myers, D., Burgio, K. L., Franklin, F., Gorin, A. A., Vittinghoff, E., Macer, J., Kusek, J. W., Subak, L. L., & Program to Reduce Incontinence by Diet and Exercise Group (2010 B). Effect of weight loss on urinary incontinence in overweight and obese women: results at 12 and 18 months. The Journal of urology, 184(3), 1005–1010.

Gozukara, Y. M., Akalan, G., Tok, E. C., Aytan, H., & Ertunc, D. (2014). The improvement in pelvic floor symptoms with weight loss in obese women does not correlate with the changes in pelvic anatomy. International urogynecology journal, 25(9), 1219–1225.

Phelan, S., Kanaya, A. M., Subak, L. L., Hogan, P. E., Espeland, M. A., Wing, R. R., Burgio, K. L., DiLillo, V., Gorin, A. A., West, D. S., Brown, J. S., & Look AHEAD Research Group (2012). Weight loss prevents urinary incontinence in women with type 2 diabetes: results from the Look AHEAD trial. The Journal of urology, 187(3), 939–944.

Pinto, A. M., Subak, L. L., Nakagawa, S., Vittinghoff, E., Wing, R. R., Kusek, J. W., Herman, W. H., West, D. S., & Kuppermann, M. (2012). The effect of weight loss on changes in health-related quality of life among overweight and obese women with urinary incontinence. Quality of life research : an international journal of quality of life aspects of treatment, care and rehabilitation, 21(10), 1685–1694.

Yazdany, T., Jakus-Waldman, S., Jeppson, P. C., Schimpf, M. O., Yurteri-Kaplan, L. A., Ferzandi, T. R., Weber-LeBrun, E., Knoepp, L., Mamik, M., Viswanathan, M., Ward, R. M., & American Urogynecologic Society (2020). American Urogynecologic Society Systematic Review: The Impact of Weight Loss Intervention on Lower Urinary Tract Symptoms and Urinary Incontinence in Overweight and Obese Women. Female pelvic medicine & reconstructive surgery, 26(1), 16–29.

Sun, Y., Chen, H., Bai, Y., Zhang, T., Bai, W., & Jiang, B. (2022). Ketogenic diet may be a new approach to treatment stress urinary incontinence in obese elderly women: report of five cases. BMC women's health, 22(1), 402.

Auwad, W., Steggles, P., Bombieri, L., Waterfield, M., Wilkin, T., & Freeman, R. (2008). Moderate weight loss in obese women with urinary incontinence: a prospective longitudinal study. International urogynecology journal and pelvic floor dysfunction, 19(9), 1251–1259.

Mahmoud ELdesoky, M. T., Mohamed Abutaleb, E. E., & Mohamed Mousa, G. S. (2016). Ultrasound cavitation versus cryolipolysis for non-invasive body contouring. The Australasian journal of dermatology, 57(4), 288–293.

El Gendy, M. H., Mohamed, R. A., & Ali, O. M. (2017). Tripollar radiofrequency lipolysis, ultrasound cavitation and combination therapy on abdominal adiposity. Int J Ther Rehabil Res, 6(1), 117-123.

Brown, S. A., Greenbaum, L., Shtukmaster, S., Zadok, Y., Ben-Ezra, S., & Kushkuley, L. (2009). Characterization of nonthermal focused ultrasound for noninvasive selective fat cell disruption (lysis): technical and preclinical assessment. Plastic and reconstructive surgery, 124(1), 92–101.

Moreno-Moraga, J., Valero-Altés, T., Riquelme, A. M., Isarria-Marcosy, M. I., & de la Torre, J. R. (2007). Body contouring by non-invasive transdermal focused ultrasound. Lasers in surgery and medicine, 39(4), 315–323.

Haar, G. T., & Coussios, C. (2007). High intensity focused ultrasound: physical principles and devices. International journal of hyperthermia : the official journal of European Society for Hyperthermic Oncology, North American Hyperthermia Group, 23(2), 89–104.